ON THE PATHOLOGY AND TREATMENT OF SHOCK AND SYNCOPE.

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ON THE PATHOLOGY AND TREATMENT OF SHOCK AND SYNCOPE.[1]

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THE assemblage of phenomena which we designate by the term "shock" is so much more frequently met with in surgical than in medical practice that it may almost seem that in writing a paper on this subject I have left the proper domain of the physician, and trespassed on that which the surgeon claims as his own. We shall hereafter see, however, that shock may occur in the course of diseases for which the physician alone is called into consultation, and it is intimately connected with fainting or syncope, a condition which is usually treated of in medical rather than in surgical text-books. So closely, indeed, are syncope and shock connected that they were considered by the celebrated surgeon, Travers,[2] to differ in degree rather than in kind, and we shall find it convenient to take a glance at the conditions which we find in syncope, before we proceed to examine those of shock.

I shall divide this paper into three parts. First, the injuries or impressions on the nervous system which occasion syncope and shock, and the symptoms which are observed in these conditions. Secondly, the causes of each symptom, and Thirdly, the re-

[1] Read before the Abernethian Society, St. Bartholomew's Hospital.

[2] Treatise on Constitutional Irritation, 1826, p. 466.

medies used and their mode of action. To put them shortly, these three heads are: 1. *The symptoms and causes;* 2. *The pathology;* and 3. *The treatment of shock and syncope.*

As I have already said, it will be convenient to consider the symptoms of syncope before those of shock. Having had little surgical experience myself, I shall quote very freely from the works of others; and the first case I shall give is one taken, not from a scientific work, but from the pages of a popular religious periodical. I cannot even vouch for the historical truth of the narrative, and yet I choose this case because we have records of numerous other ones which resemble it so much in one or more particulars, that we can hardly doubt the substantial accuracy of the description; and owing to the peculiar circumstances under which the events are said to have taken place, we find in this one instance all the phenomena which we would otherwise have to seek for: some in one case, some in another.

During the reign of Charles or James the Second, one of the Scottish Covenanters, named John Bruce, concealed himself from the dragoons who were in search of him at some little distance from his cottage, and his little daughter Alice was accustomed daily to visit him with a supply of provisions. One day, while on this errand, she was unhappily discovered and seized by the dragoons, who at once guessed her purpose from the food she was carrying, and declared that unless she informed them of the place of her father's concealment they would torture her with thumb-screws. She refused, and the instruments were accordingly applied. Scarcely, however, had a few turns of the screw been made, when her face became deadly pale, and she fell back insensible. The screw was at once undone, water from a neighbouring rivulet was dashed in her face, and after a deep sigh or two the paleness disappeared and consciousness returned. Again the dragoons demanded her secret, adding the threat that they would not let her off so easily this time. Again she refused, and the dragoons, irritated by her obstinacy, by a few rapid turns of the screw nearly crushed her thumbs between the jaws of the instrument. A second time the deadly pallor overspread her face, and unconsciousness relieved her pain. This did not suit the purpose of the dragoons, and they again

sought to restore her as before. But this time all their efforts were unavailing; the heart had ceased to beat, and the poor child was dead.

Here we have a typical instance, first of fainting, then of death by syncope, following the infliction of intense pain alone, without any injury whatever to the vital organs. Sometimes death may occur from an impression on the nervous system without even pain being felt, as in a case recorded by Sir Astley Cooper in his lectures on surgery.[1] "A healthy labourer belonging to the India House was attempting to lift a heavy weight, when another labourer came up and said, 'Stand on one side; let an abler man try.' At the same time he gave the former a slight blow on the region of the stomach, when the poor fellow immediately dropped down and expired. On examination of his body there was not any mark of violence discovered." This may be regarded as a typical instance of instant death from shock, but cases like it are comparatively rare. Usually the injury is succeeded by a period of depression of all the vital functions, and this may either end in death, pass into a state of excitement, or gradually disappear and give place at once to health without any intervening excitement.

The symptoms ordinarily observed in shock are well illustrated by a case which Professor Fischer has described in a clinical lecture on this subject.[2] From this I have made the following extracts:—"The patient, a strong, and perfectly healthy young man, was struck in the abdomen by the pole of a carriage drawn by runaway horses. No serious injury was done to any of the internal organs, at least we have not been able after a careful examination to find any trace of one. Nevertheless, the grave symptoms and the alarming look which he still presents made their appearance immediately after the accident. He lies as we see perfectly quiet, and pays no attention whatever to anything going on around him. His countenance is sunk and peculiarly elongated, his forehead is wrinkled, and his nostrils dilated. His weary, lustreless eyes are deeply sunk in their sockets, half-covered by his drooping eyelids, and surrounded by broad dark rings. The pupils are dilated, and re-

[1] Lectures on Surgery, from notes by Tyrrell, 1824, vol. i. p. 10.
[2] Volkmann's Sammlung Klinischer Vorträge, No. 10.

act slowly to the light. He stares purposelessly and apathetically, straight before him. His skin and such parts of the mucous membranes as are visible are pale as marble, and his hands and lips have a bluish tinge. Large drops of sweat hang on his forehead and eyebrows. His whole body feels cold to the hand, and a diminution in temperature is readily detected by the thermometer, which indicates a degree and a half in the axilla, and a degree centigrade in the rectum, below the normal. Sensibility is much blunted over the whole body, and only when a very painful impression is made on the patient does he fretfully pull a wry face and make a languid defensive movement. He does not move a single limb spontaneously, but after being repeatedly and urgently requested, he shows that he can still execute limited and brief movements with his extremities. If the limbs are lifted and then let go, they immediately fall as if dead. The sphincters remain closed in our patient, at least passage of urine and fæces has not been noticed since he came into the hospital. When drawn off with the catheter, the urine is found to be scanty and dense, but free from any traces of sugar or albumen. The pulse is almost imperceptible, irregular, unequal, and very rapid. The arteries are small, and the tension very low. While the patient was being brought to the hospital the pulse became quite imperceptible, and the cardiac sounds very irregular and intermittent. The patient is perfectly conscious: he replies very slowly and only when repeatedly and importunately questioned, but his answers are quite to the point. You heard how he gave the details of the accident reluctantly and imperfectly, but in the main correctly. Only while he was being brought to the hospital did he refuse to answer at all. His voice is hoarse and weak, but his articulation is good. On being repeatedly questioned the patient complains of cold, faintness, formication, and deadness of the extremities. When he shuts his eyes he becomes sick and giddy. His senses are perfectly acute. His respiration appears to be irregular, and abnormally long, deep and sighing inspirations alternate with very superficial ones, which are scarcely visible or audible. While being brought to the hospital he vomited several times, and nausea and hiccup still remain. Anyone who knew the patient, or had seen him shortly before the accident, could hardly

recognise him now. His appearance, cold skin, and hoarse voice immediately recall the appearance of a cholera patient to the memory of the attentive observer; the characteristic dejections are alone wanting to make the resemblance complete."

But cases of shock do not always present these appearances. If we call the form just described the torpid one, we can readily distinguish from it another erethismic form which Travers terms "prostration with excitement."[1] The countenances of patients suffering from it are distorted, and express a nameless anxiety and excruciating agony. They toss wildly about, groan and scream, and complain of a fearful oppression and want of breath, oppressive presentiments of death, and a feeling of total annihilation. No encouragement is of any use; they lament and behave themselves like madmen. The consciousness of these sleepless and restless patients is unclouded, but seems to be completely engaged by the frightful anguish. On this account they answer no questions, but only sigh and moan. They murmur to themselves, and pay no attention to what is going on around them. Such parts of the mucous membranes as are visible are pale, but the countenance, on the contrary, is slightly flushed, and the forehead hot; the eyes are sunk, but have a peculiar lustre, and the pupils are contracted. The skin of the extremities is generally cool and insensible, but not to the same degree as in the torpid form of shock seen in the case of the patient already described. Occasionally no coldness is perceptible. Vomiting of quantities of mucus and painful retching are constant and very obstinate symptoms of this form of shock. Burning thirst is present, and liquids are greedily swallowed, but no sooner are they down than they are again rejected. Every movement is made hastily and accompanied by a remarkable trembling. Occasionally all the limbs shiver as in a rigor, and the patient has no power to control the movement. A wounded officer in this condition repeatedly requested me, says Professor Fischer, not to consider it as a sign that he was afraid. Convulsive movements, and fibrillary twitches of the muscles, and especially of those in the face, are observable. The respiration is frequent and superficial, the pulse small and cannot be counted.

[1] Op. cit. p. 407.

Both these forms of shock may occur independently, but there is a certain connection between them. Patients recovering from the torpid form may come gradually to present the symptoms of the erethismic, and *vice versâ*, when the condition becomes worse, the torpid may be developed from the erethismic form. The latter is then to be regarded sometimes as an independent condition, and sometimes as a second stage of the torpid form.

Both forms of shock sometimes terminate in death, while at other times, according to Mr. Travers,[1] instead of the continuance and fatal increase of the symptoms of prostration, they may gradually give place to a partial and defective reaction, protracting life, but scarcely improving the prospect of restoration, which remains doubtful for several days in succession; or, on the contrary, an efficient and healthy degree of reaction may be quickly established consequent upon symptoms threatening the most unfavourable issue. "Again and again," he continues, "I have left the bedsides of patients brought into the hospital pulseless, and apparently moribund without any external injury, having suffered falls or blows so serious as to have induced the symptoms of prostration to an alarming extent, and have found them on the succeeding day, to my great surprise, restored to the tone and tranquillity, comparatively speaking, of health. Reaction has in these cases been spontaneous, or nearly so, although gradual enough to occupy a period of many hours." "Now, had such persons suffered topical injuries of a severe though reparable description, it is to my mind more than probable that reaction would have failed altogether; but had it, by favour of circumstances, been established it is at least, equally probable that it would have taken the form of excitement. In other cases days have elapsed before a perfect reaction and complete relief have been obtained."

Having said so much regarding the symptoms of shock, let us shortly run over its causes. The cases already related show us that it readily follows a blow on the abdomen, sometimes even when the blow is by no means severe. Injury to the genitals is another important cause of shock. Hardly

[1] Op. cit. p. 409.

anyone finishes his school days without receiving a blow on the testicles, either at cricket or during the struggles at foot-ball, and ever afterwards he bears vividly in mind the dreadful depression, weakness, and sickness which instantly overpowered him. The same thing takes place in operations, and Mr. Erichsen[1] has observed that at the moment of division of the spermatic cord in castration the pulse sinks even though the patient has been fully anasthetised. Still more striking are the effects occasionally observed on the passage of a catheter or bougie. They are thus described by Sir Astley Cooper:[2] "A person has a bougie passed into his urethra for the first time; the urethra is irritated by it; he says, 'I feel faint,' becomes sick, looks pale, and, without care, he drops at your feet. His pulse has nearly ceased, and his body is covered with a cold perspiration. You place him on a sofa with his head a little lower than his body, and as soon as the blood freely enters the brain all his functions are restored. Thus, by irritating the urethra the stomach is influenced, the actions of the head and heart are suspended, and the powers of the mind vanish."

Injuries to bones have a peculiar power to induce shock. It is, perhaps, more frequently observed as a consequence of the crushing of bones in railway accidents than of any other cause whatever. It may be said that in such cases all the textures of the limb, skin, fascia, muscles, vessels, and nerves are injured as much as the bones; but two cases of Pirogoff's[3] seem to show that it is to injury of the latter rather than of the former structures that the effect is to be attributed. In two amputations of the thigh which he performed, before the introduction of chloroform, death occurred on the operating table.

One case was for severe traumatic injury, the other for chronic disease of the knee-joint, which had greatly weakened the patient. In both cases the pain and loss of blood during the operation was only a little greater than usual, yet, in both, immediately after the bone had been sawn through the face became pale, the eyes staring, the pupils dilated, a peculiar rigidity of the body occurred, and death immediately took place.

[1] Science and Art of Surgery, 4th edit. p. 6.

[2] Lectures on Surgery, from notes by Tyrrell, 1824, vol. i. p. 9.

[3] Quoted by Fischer, op. cit. p. 10.

Extensive burns frequently cause shock in a marked degree, and such, says Mr. Travers,[1] is the effect of the transient bodily pain experienced in the extraction of a tooth, or the extirpation of a wart or corn, as in some persons to produce syncope, retching, or convulsions. Nor must the effect of mental emotion be left out of account, as this is sometimes sufficient of itself to cause death without any injury to the body whatever. Many years ago the janitor of King's College, Aberdeen, had rendered himself in some way obnoxious to the students, and they determined to punish him. They accordingly prepared a block and axe, which they conveyed to a lonely place, and having dressed themselves in black, some of them prepared to act as judges, and sent others of their company to bring him before them. When he saw the preparations which had been made he at first affected to treat the whole thing as a joke, but was solemnly assured by the students that they meant it in real earnest. They proceeded to try him, found him guilty, and told him to prepare for immediate death, for they were going to behead him then and there. The trembling janitor looked all round in the vain hope of seeing some indication that nothing was really meant, but stern looks everywhere met him, and one of the students proceeded to blindfold him. The poor man was made to kneel before the block, the executioner's axe was raised, but instead of the sharp edge a wet towel was brought smartly down on the back of the culprit's neck. This was all the students meant to do, and thinking that they had now frightened the janitor sufficiently, they undid the bandage which covered his eyes. To their astonishment and horror they found that he was dead.

Another case is related by Mr. Travers,[2] who saw a man suffering from strangulated hernia expire suddenly on the table during the steps preliminary to the operation which, from the state of the symptoms and of the bowel as ascertained by examination after death, might be said to afford the fairest prospect of relief.

The cases of shock of which we have so far spoken are perhaps more likely to come under the notice of the surgeon than of the physician. The state of shock, or collapse as it is more frequently called in medical practice, occurs when the

[1] Travers, op. cit. p. 74. [2] Op. cit. p. 23.

abdominal viscera are injured from within, just as when they receive a blow from without. Thus the intense irritation which corrosive poisons, such as sulphuric and other mineral acids, or large doses of arsenic, occasion in the stomach, produces, in addition to local pain, coldness and pallor of the surface, sighing respiration, and weak or imperceptible pulse. The same thing occurs when perforation takes place in the stomach or intestines, and their contents escape into the peritoneal cavity. The occurrence of shock after parturition, especially in cases of twins, is probably partly due to nervous influence and partly to the removal of pressure from the abdominal vessels by the loss of such a large portion of the abdominal contents, which must almost unavoidably occasion more or less relaxation of the vessels.

To recapitulate shortly what we have said under this head, the *symptoms* of shock are: pallor and coldness of the skin, weak pulse, oppressed and sighing respiration, dilated pupil, and sickness.

The *causes* of shock are: painful impressions—more especially extensive burns—injuries to bones, and, above all, injuries to the abdominal viscera and genitals.

We have now to consider our second head, viz.: *The pathology of shock; or, the causes of each symptom.* I ought properly to take up every one and trace it back to its cause, but I shall not attempt to do this, because it would occupy too much time, and I am not sure I could at present succeed in the attempt. I shall, therefore, be content to glance at a few of the principal symptoms only.

And first:—Why should the pulse be small and weak and the tension in the artery low, so that a slight pressure with the finger is sufficient to compress its walls and completely arrest its pulsations? The smallness of the pulse wave under such conditions at once informs us that only a little blood is sent into the arteries at each contraction of the heart. This may be owing to the heart acting so feebly and imperfectly that it only sends out a small portion of the blood with which its cavity was filled, or it may be that it is doing its duty perfectly but has no blood to send out. It be would very hard to say which of these two causes is the true one, or whether they do not

both share in the production of shock, if we had not experiments on the lower animals to give us some clue to the true solution. Several years ago Professor Goltz, now of Strasburg, found that on striking the abdomen of a frog several times the heart stopped still altogether.[1] After a short pause it again went on, but instead of becoming completely full during each diastole, and sending a large volume of blood into the arteries at each systole, it remained pale and empty; no blood at all, or hardly any, flowed into it during the diastole, and consequently it could not send any into the vessels when it did contract, and it might just as well have remained motionless. On looking for the blood that ought to have been supplying the heart, he found that it was stagnating in the vessels of the abdomen, and especially in the veins. The intestinal vessels are so capacious that when they are fully dilated they can hold all the blood in the body. Normally, however, they are kept in a state of partial contraction by the influence of the vaso-motor nerves which supply them. It used to be supposed that these nerves only went to the arteries, and that these alone were capable of contraction and relaxation, but Goltz found that the veins also were supplied by vaso-motor nerves, and that they too could contract and dilate, though to a less extent than the arteries. Whenever the power of the vaso-motor nerves was destroyed, both arteries and veins dilated and held so much blood that there was not sufficient left to keep up the circulation in the rest of the body. If the frog was held in the upright position no blood at all reached the heart, but if it was laid horizontally a little blood trickled into the heart, and the circulation was thus kept up, though very weakly.

Here, then, we have in the frog the same effects produced by a blow on the abdomen, as in the case of the young man who was struck by the carriage pole, with this difference, that in the man we could only feel the weakness of the pulse, while in the frog we can see why it is weak. Professor Fischer says that the best and shortest definition of shock which has yet been given is that of Mr. Savory:—"Shock is the paralysing influence of a sudden and violent injury to nerves over the activity of the heart." The experiments of Goltz show that this

[1] Virchow's Archiv. xxvi. p. 11, and xxix. p. 394.

definition is perfectly correct, but you must not forget that there are the two factors in shock as seen in the frog. First, the stoppage of the heart; and second, dilatation of the vessels. These are quite distinct, and I have frequently observed that blows of moderate severity will produce in some frogs stoppage of the heart without dilatation of the vessels; in others vascular dilatation without arrest of the cardiac pulsations, although severe blows generally produce both.

The pallor of the surface and the coldness of the skin are the next symptoms which engage our attention, and what we have just learned regarding the circulation will render their explanation easy. The rosy flush of health is due simply to the red colour of the blood shining through the skin as it courses through the capillaries, and whenever the circulation is stopped, either by the vessels contracting as after exposure to cold, or by the blood stagnating in the abdomen as in shock, pallor overspreads the surface. The warmth of the external parts of the body is due to the warm blood from the interior, which heats them in the same way that rooms are warmed by hot-water pipes, and whenever the circulation ceases there is nothing to prevent the surface of the body being cooled down to the temperature of the surrounding medium, and such, in fact, does take place. The lividity or blueness which is occasionally observed, is due to the blood in the capillaries becoming dark and venous as it flows sluggishly through them, or even stagnates in them altogether when the circulation is very weak. I shall at present say nothing about the respiration or sickness, but pass on to consider the insensibility which we find in syncope though not in shock, and which distinguishes the former from the latter.

The functions of the brain, on whose failure insensibility depends, require for their performance a constant supply of blood, and when this is cut off they at once cease. A year or two ago, Dr. Waller proposed to produce temporary anæsthesia for short operations by compressing both carotids, or, in fact, garotting the patient; and I have been informed by my friend Mr. Image, of Bury St. Edmunds, that in Baron Larrey's Hôpital du gros Caillou, in Paris, it was the usual custom before the introduction of chloroform to lay a patient on his back, and then to lift him

up very suddenly to the standing posture, whenever they wished to induce fainting for the purpose of relaxing muscles in cases of dislocation. The vessels of the patient were carrying on the circulation all right while he was in the horizontal position, but they had not time to adapt themselves to the altered conditions when the man was placed upright, and so the blood ran to the depending parts of the body, and the brain was left without it.

But why should a fainting fit, which, apparently, is more severe than shock, inasmuch as the brain also has ceased to act and the patient is thus rendered more deathlike, be quickly recovered from, while shock lasts for many hours? This is a question difficult to answer, inasmuch as the necessary data fail, and we are forced to fall back on hypothesis. In attempting to answer it we must remember that it is not really the heart's action which keeps up the circulation directly. It is the pressure of the blood inside the arteries forcing it on through them, and, as Goltz's experiment shows, the heart may be pulsating and yet the circulation be at a standstill. Now, the arterial tension may be lessened, (1) by the heart stopping, or (2) sending little blood into the arteries at each beat, or (3) by the arterioles dilating so as to let the blood easily out from the arteries into the veins, where it may stagnate and be useless. Another point we must remember is that it is the circulation in the brain which is the important factor in producing insensibility. In the patient who was suddenly lifted on his feet the circulation in the body was going on perfectly well; it only failed in the brain.

Now, it is very easy to bring down the blood-pressure very much by stopping the heart for a few instants, and it may take a little while before it rises to its normal condition. A second way is to dilate the arterioles, and if the arterioles be dilated at the same time that the heart is stopped, the pressure will fall with great rapidity, and, when the heart again begins to beat, it will take a much longer time to raise the pressure sufficiently to carry on the circulation than it would otherwise do. Now, when a painful impression is made on a sensory nerve, it is not unfrequently carried up to the medulla oblongata, where it is transferred to the vagus nerve, which, as you know, has the

power of stopping the heart, and by setting this nerve into action arrests the cardiac pulsations. If the arterioles should happen to be dilated, as they almost always are in a warm room, the pressure of blood in the arteries immediately sinks, the brain getting an insufficient supply ceases to act, and the patient falls down unconscious. The very fact of the head being lowered induces more blood to pass to it, and the normal condition is at once in many cases restored.

The condition of the vessels in fainting has not been ascertained, and the only observation bearing on the subject that I can find is one by John Hunter.[1] While engaged in bleeding a lady she fainted, and during the continuance of the faint he observed that the blood which flowed from the vein, instead of being dark and venous, was of a bright scarlet colour, like that of arterial blood. Now, the only condition in which we know this to take place is when the arterioles are greatly dilated, and the blood flows so quickly through them that there is no time for it to be deprived of oxygen during its passage. This is seen in the submaxillary gland during irritation of the chorda tympani nerve, and it was observed by Meyer,[2] the celebrated propounder of the doctrine of conservation of energy, in persons whom he bled in the tropics, and who had their vessels dilated in consequence of the heat; and it was also noticed by Crawford[3] in animals bled during immersion in a warm bath. It would

[1] Works of John Hunter, edited by Palmer, 1837, vol. iii. p. 91.

[2] R. Meyer, Die organische Bewegung in ihrem Zusammenhang mit dem Stoffwechsel, 1845, p. 84. Meyer's explanation of the occasional red colour of venous blood is different from the one I have given above. We both agree that the slightness of the alteration it has undergone in its passage from the arteries into the veins is due to the fact that but little oxygen has been taken from it by the tissues as it flowed through the capillaries. Meyer considers that the tissues adapt themselves to the wants of the body, and take little oxygen from the blood when the external air is warm. The oxidation which usually goes on within the body is thus diminished, the production of the heat lessened, and the temperature of the animal prevented from rising too high. This hypothesis, though very plausible, is rendered improbable by the experiments of Bernard (*Revue Scientifique*, 1871-72, pp. 133 and 182), which show that the tissues of animals which have been exposed to a high temperature absorb oxygen (after death at least) much more quickly than usual. I therefore attribute the florid colour of the blood to dilatation of the arteries and capillaries, allowing it to flow so quickly through them that the tissues have not time to abstract much oxygen, however great their avidity for it may be.

[3] Crawford, Experiments and Observations on Animal Heat, 1788, p. 308.

therefore seem that in fainting the vessels of the external parts of the body are occasionally, at least, widely dilated, and this explains the frequency with which persons faint in warm rooms and crowded churches. I am inclined then to suppose, that in fainting there is dilatation of the vessels in the *external* parts of the body, although the data on which I found my opinion are too imperfect to allow of my speaking very positively on the subject. If you examine the veins on the back of your hand in a crowded assembly, such as people often faint in, you will probably find them very full, indicating that blood is flowing rapidly into them from the arteries, and that their colour is of a lighter blue than usual, showing that the blood they contain is lighter coloured or less venous than usual. This indicates that the cutaneous arterioles are dilated, and this dilatation has doubtless a great deal to do in many instances with the reduction of the blood-pressure and the induction of syncope. As the skin is usually pallid during the fainting fit itself, we can hardly suppose that the blood is then flowing very rapidly through the cutaneous vessels. If the hypothesis I have just advanced be correct, we are thus driven to the conclusion that it is the blood-vessels of the muscles which undergo dilatation during syncope. This idea likewise receives confirmation from the observation made by Thackrah,[1] that it is in muscular men that venous blood most frequently presents a florid colour. Such of you as have seen a living muscle cut across, however, know that when it is at rest very little blood indeed flows from the divided ends of the vessels which permeate its substance, and you may be inclined to doubt the possibility of these vessels ever being able to dilate so much as to drain, as it were, the blood from the arteries into the veins and produce syncope. That they can dilate and drain the blood out of the arteries very quickly has been shown by Ludwig and Hafiz,[2] who found that when the vessels of the intestines and skin were made to contract, the blood which could no longer flow through them poured through the vessels of the muscles, and, notwithstanding the fact that these vessels were at that very time excited to contraction by irritation of their vaso-motor nerves, the blood flowed from the arteries into

[1] Thackrah, Inquiry into the Nature and Properties of the Blood, p. 85.
[2] Ludwig's Arbeiten, 1871, p. 107.

the veins, and the pressure in the arteries sunk nearly as quickly as when the cutaneous and intestinal vessels were putent. If such be the effect of the muscular arteries on the blood-pressure when they are trying to contract, what must it be when they are ready to dilate? Dilatation of the vessels alone may sometimes be sufficient of itself to lower the blood-pressure to such an extent that fainting occurs; but at other times this is combined with the depressing effect of sudden stoppage of the heart. In shock there is great dilatation of the vessels in the *interior* of the body, especially in the veins of the intestine. If this state should be associated with sudden stoppage of the heart, instant death will occur, as in the case of the labourer in the India Docks. In short, then, I consider syncope to depend chiefly on dilatation of the arterioles, especially of those near the surface, though in cases like that of Alice Bruce it may be due entirely to stoppage of the heart; while the chief factor in shock is dilatation of the abdominal veins. The longer duration of shock than of syncope is probably due to the veins recovering their contractility more slowly than the arterioles.

Having thus formed some sort of idea regarding the pathology of syncope and shock, we come to our third head, viz. the question of treatment. In syncope, our first idea is to restore the circulation to the brain, and this we do by laying the head level with the body, or perhaps, still better, as recommended by Sir Astley Cooper, on a level somewhat lower than that of the body.

The next thing is to raise the blood-pressure. Now, this is most easily done by causing the arterioles to contract. We therefore hurry a person who has fainted from the warm room to the cold air, and dash cold water on the face, in order to cause contraction of the vessels on the surface of the body. We also give draughts of cold water to cause contraction of those of the stomach. Besides this we apply ammonia or aromatic vinegar, which is strong acetic acid, to the nose. Why do we do this? Many of you know that when ammonia is applied to the nose of a rabbit it causes the heart to stop instantaneously, and one would therefore think that to hold it before a fainting person's nose was to do the very worst possible thing. But we all know that this is not the case. Some time ago a member

of this society asked me this question, and I could at that time give him no satisfactory answer. I have since made some experiments on the subject, and I find (what has indeed been already noticed by Kratschmer [1]) that when ammonia or strong acetic acid is held before the rabbit's nose, it causes contraction of the arterioles. Consequently it prevents the blood-pressure from falling quickly, even should the heart become feeble or stop, and is thus useful in preventing syncope. When the blood-pressure has already become lowered by the occurrence of syncope, contraction of the arterioles causes it to rise, and it is by causing this that acetic acid or ammonia are useful as restoratives.

In shock we have two conditions to remove. The first of these is the feebleness of the heart itself, which is due to the action of the vagus. To counteract this we apply stimulants. Now, one of the most powerful stimulants to the heart is heat. It is true that it dilates the vessels, but in shock we have nothing to fear from dilatation of the vessels near the surface of the body, where circulation is hardly going on at all, nor is it likely that it will increase the dilatation of those in the interior. We therefore pursue a plan of treatment directly the opposite of that which we employ in fainting, and apply warmth instead of cold to the surface, especially to the cardiac region, over which a hot poultice or india-rubber bottle filled with hot water should be placed. At the same time, and for a similar purpose, we give brandy and ether internally. The second and most important indication for treatment is to cause contraction of the great vessels, especially the veins in the abdominal and thoracic cavities, so that the blood, instead of stagnating uselessly in them, may be sent onwards to the heart, and thence to the rest of the body. I have already described the effect of acetic acid and ammonia held before the nose, but this is only one example of the general rule that all powerful impressions on sensory nerves cause contraction of the blood-vessels. Painful impressions made upon the skin, for example, have this effect, and Goltz has shown that pinching the toes of a frog, or irritating them by acetic acid, prevents the vessels from dilating when the abdomen is struck, or causes them to contract and propel the blood to the heart if dilatation has already taken place. If I may judge

[1] Wiener Litz. Bericht, 1870, Abt. II. lxii. p. 24.

from my own experience, persons not unfrequently take unconscious advantage of this effect of pain, and medical students occasionally prevent themselves from fainting, when witnessing an operation, by biting their lips or pinching their fingers. Its beneficial action in shock is very great, and my friend Dr. Fayrer informs me that he has succeeded in recovering a patient from a state of collapse by thrashing his feet and the calves of his legs with switches after other means had failed. Mustard plasters are often applied for a similar purpose. Sometimes the performance of an operation during shock is attended by a marked improvement in the patient's condition, and it seems to me not improbable that this is due to the stimulus thus given to the vasomotor nerves. At other times, however, the additional injury seems to produce an injurious effect either on the heart or vessels, and the patient succumbs. It is possible that the different effects of operations performed during shock may depend to some extent on the greater or less amount of irritation which is occasioned to the nerves of bones as compared with those of the soft parts; for, as we have already mentioned, injuries to bones tend to cause syncope, while irritation of other nerves, unless it be excessive, tends to prevent it by raising the blood-pressure. This, however, is a question which pertains more especially to surgeons, and with them I will leave it. I must not conclude without mentioning another valuable remedy in cases of shock, viz., digitalis. It has, I think, been conclusively proved by Dr. Adolf B. Meyer and myself,[1] that this drug possesses the power of contracting the arterioles, and I have shown[2] that it greatly strengthens the pulsations of the heart. We would therefore expect it to prove useful in shock, and experience does not disappoint our anticipations. This is well shown by a case of shock following parturition, in which it was employed by Dr. Wilks[3] some years ago. My attention was drawn to this by my friend Dr. Milner Fothergill, and I quote the following from his admirable essay on digitalis.[1] "The patient was apparently *in articulo mortis;* her limbs were cold, her body in a state of deathly clammy sweat; the face was livid, no pulse could be felt at

[1] Journal of Anatomy and Physiology, Nov. 1872, p. 134.
[2] On Digitalis. London, 1868, p. 28.
[3] *Medical Times and Gazette,* Jan. 16, 1864.

the wrist, and a mere fluttering was heard when the ear was placed over the region of the heart. Brandy and ether had been tried without any good effect, and as dissolution was imminent, it was determined to try digitalis. Half-drachm doses were given every hour: after four doses a reaction took place, and after seven doses complete recovery occurred." Such a case as this needs no comment, and a consideration of the encouraging results here obtained can hardly fail to gain for digitalis a much more extensive application in cases of shock than it has hitherto received.

[1] Digitalis: its Mode of Action and its Use. London, 1871, p. 63.